

**QUANTITATIVE PRECIPITATION AND HYDROMETEOR CONTENT
ESTIMATION IN TROPICAL CYCLONES FROM REMOTE
SENSING OBSERVATIONS**

by

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ABSTRACT

Quantitative rain rate and hydrometeor content retrievals from spaceborne remote sensing measurements in tropical cyclones over ocean and related microphysics issues are discussed in this study. An emission-based rainfall rate algorithm for the Stepped Frequency Microwave Radiometer (SFMR) on the National Oceanic and Atmospheric Administration (NOAA) hurricane research aircraft WP-3D is validated by using simultaneous observations from two radars on the same aircraft. Data collected in Hurricane Bonnie (1998) and Humberto (2001) are used in the comparisons. It is found that a coefficient in the attenuation – rain rate relationship used in the existing SFMR algorithm is incorrect. After the algorithm correction, a linear regression result with a correlation coefficient of 0.8 and a slope close to 1 is obtained between SFMR and radar derived rain rates. But an overall high bias of 5 mm/hr of the SFMR rainfall estimate relative to radar is also found, which is related to the comparison scheme. The error analysis shows that the bias is nearly independent of rain type, a result in agreement with previous results that the rain drop size distributions between convective and stratiform rain in hurricanes are similar.

A combined radar-radiometer algorithm is developed to estimate hydrometeor profiles in tropical cyclones and convection over ocean for the Tropical Rainfall Measurements Mission (TRMM). It is designed to adjust the parameters in the exponential particle size distribution (PSD) for rain, snow, and graupel iteratively by minimizing the difference between observed brightness temperatures and simulated ones.

The algorithm is first applied to the aircraft observations to evaluate the performance. A comparison of the retrieval results with aircraft *in situ* measurements, independent radiometer observations, and other retrieval algorithms indicates that the algorithm can provide reliable hydrometeor content estimates and that the radar-only retrieval is improved by including brightness temperature data into the combined algorithm. The application to the TRMM case shows that the beamfilling bias for the combined algorithm is comparable to that for the radar-only algorithm other than as large as that for the radiometer-only algorithm. The largest variability is found for the retrieval in the Hurricane Isabel (2003) eyewall convective region, indicating that the eyewall represents the most complicated condition for the remote sensing retrieval.

TABLE OF CONTENTS

ABSTRACT	iv
ACKNOWLEDGEMENTS.....	vii
CHAPTERS	
1. INTRODUCTION	1
1.1 Tropical Cyclones.....	1
1.2 Background of Microwave Remote Sensing.....	4
1.2.1 Overview.....	4
1.2.2 Passive Microwave Remote Sensing of Precipitation.....	7
1.2.3 Active Microwave Remote Sensing of Precipitation.....	18
1.2.4 Beamfilling Problem of Space-based Microwave Observations.....	21
1.3 Inversion Problem and PSD Issues.....	22
1.4 Outline.....	23
2. VALIDATION OF RAIN RATE ESTIMATION IN HURRICANES FROM THE STEPPED FREQUENCY MICROWAVE RADIOMETER (SFMR)—ALGORITHM CORRECTION AND ERROR ANALYSIS.....	24
2.1 Abstract.....	24
2.2 Introduction.....	25
2.3 Data Sources and Processing.....	30
2.3.1 SFMR Data.....	30
2.3.2 TA Radar Data.....	32
2.3.3 LF Radar Data.....	33
2.4 Comparison of Results and Algorithm Correction.....	35
2.4.1 Regression Analysis.....	35
2.4.2 Algorithm Correction.....	39
2.5 Error Analysis.....	48
2.5.1 Rain Type Dependence of Error.....	49
2.5.2 Wind Speed Dependence of Errors.....	52
2.5.3 Radial Dependence of Errors.....	54
2.6 Discussion.....	56
2.7 Conclusion.....	59
2.8 Appendix.....	60
3. RETRIEVAL OF HYDROMETEOR PROFILES IN TROPICAL CYCLONES AND CONVECTION BY A COMBINED RADAR-RADIOMETER ALGORITHM.....	67

3.1	Abstract.....	67
3.2	Introduction.....	69
	3.2.1 Importance of Hydrometeor Profiles in Tropical Cyclones and Convection.....	69
	3.2.2 Existing Algorithm Review.....	70
	3.2.3 Special Goals.....	80
3.3	Instrumentation.....	83
	3.3.1 CAMEX-4.....	83
	3.3.2 TRMM.....	87
3.4	Algorithm Description.....	90
	3.4.1 The RTM.....	92
	3.4.2 Hydrometeor Content Calculations.....	95
	3.4.3 Inversion Procedure.....	102
3.5	Sensitivity Tests.....	103
3.6	Application to CAMEX-4 Observations.....	120
	3.6.1 Dataset.....	120
	3.6.2 Quality of Inversion.....	122
	3.6.3 Comparisons of IWC and N_0 Retrievals with Aircraft <i>In Situ</i> Measurements and Radar-Only Retrievals.....	124
	3.6.4 Comparisons of 50 GHz Brightness Temperature Calculations with HAMSr Observations.....	137
	3.6.5 Comparisons of LWC and Surface Rain Rate Retrievals with Radar-only and Radiometer-only Retrievals.....	141
3.7	Application to TRMM Observations.....	149
	3.7.1 Implementation.....	149
	3.7.2 TRMM Beamfilling Problem and Analysis Method.....	151
	3.7.3 Case Study for Stratiform Regions in Hurricane Isabel (2003).....	155
	3.7.4 Case Study for Eyewall Regions in Hurricane Isabel (2003).....	174
3.8	Summary and Discussion.....	185
	REFERENCES.....	194

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